Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: CH305

Course Name: CHEMICAL REACTION ENGINEERING-I (CH)

Max. Marks: 100 Duration: 3 Hours

(Graph sheets shall be supplied)

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Describe the classification of industrial reactors. (4)

b) List out the steps of reactor design procedure. (5)

c) Derive the expression for finding out the temperature dependency of rate constant based on collision theory. (6)

2 a) Define pseudo steady state hypothesis. List different types of intermediates with example. (5)

b) Device a mechanism for free radical polymerisation. (5)

c) The decomposition of reactant A in a batch reactor using pressure units show exactly the same rate at two different temperatures: (5)

At 400K is $(-r_A) = 2.3\ P_A^2$ mol/m^3.s

At 500Kis $(-r_A) = 2.3\ P_A^2$ mol/m^3.s, where $P_A$is in atmospheres.

Evaluate the activation energy in J/mol.

3 a) Device a mechanism for the reaction between Hydrogen and Bromine. The reaction is as follows. (5)

$H_{2(g)} + Br_{2(g)} \leftrightarrow 2HBr_{(g)}$;

$$\frac{d[\mathrm{HBr}]}{dt} = \frac{k'[\mathrm{H_2}][\mathrm{Br_2}]^{1/2}}{1 + k''\dfrac{[\mathrm{HBr}]}{[\mathrm{Br_2}]}}.$$

b) Explain stirred contained solid reactor with neat sketch. (5)

c) The pyrolysis of ethane proceeds with an activation energy of about 300KJ/mol. How much faster is the decomposition at 650^{0}C than at 500^{0}C. (5)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive the rate equation for irreversible second order reaction using integral method. (5)

b) Derive the rate equation for varying volume batch reactor for irreversible second order reactions of the type 2A giving products. (5)

c) A 10 minute experimental run shows that 75% of liquid reactant is converted to product by a half order rate. What would be the fraction converted in half hour run? (5)

5 a) Derive the design equation for ideal plug flow reactor. (3)

b) In an isothermal batch reactor 70% of a liquid reactant is converted in 13 minutes by first order kinetics. What space time and space velocity are needed to effect this conversion in a PFR and MFR. (5)

c) An aqueous feed of A & B (400 l/min, 0.1 mol A/l, 0.2 mol B/l) is to be converted to product in a PFR. The kinetics of the reaction is represented by A + B $\longrightarrow$ R, $-r_A = 200\ C_A\ C_B$(mol/l. min). Find the volume of the reactor needed for 99.9% conversion of A into product. (7)

6 a) In the presence of a homogeneous catalyst of given concentration, aqueous reactant A is converted to product at the following rates in a batch reactor and concentration of A alone determines the rate. (8)

C_A	1	2	4	6	7	9	12
$-r_A$	0.06	0.1	0.25	1	2	1	0.5

The reaction is conducted in a batch reactor. Find the time needed to lower the concentration from 10 moles/l to 2 moles/l.

b) The homogeneous gas decomposition of phosphine follows the reaction $4PH_3(g) \longrightarrow P_4(g) + 6\ H_2$ proceeds at 649^0C with first order rate having a rate expression $-r_{PH_3} = 10\ hr^{-1}\ C_{PH_3}$. What size of PFR operating at 649^0C and 460KPa can produce 80% conversion of a feed consisting of 40 mol of pure phosphine per hour. (7)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive the performance equation for recycle reactor and the expression for optimum recycle ratio. (10)

b) For the elementary reactions in series $A \xrightarrow{k_1} R \xrightarrow{k_2} S$, $k_1 = k_2 = k$ at time t=0, $C_A = C_{A0}$, $C_{R0} = C_{S0} = 0$. Find the maximum conversion of R and when it is reached? (10)

8 a) Explain with a neat sketch about reactive distillation. (5)

b) Classify different types of membranes used for membrane reactors. (5)

c) Develop the kinetic expressions for competitive and non-competitive inhibition. (10)

9 a) Develop the procedure to determine the best arrangement of reactors in seriesfor autocatalytic reaction with and without recycle. (10)

b) Derive the Michaelis-Menten equation for enzyme catalysed reactions. (5)

c) Develop the performance equation for enzyme catalyse reactions in batch reactor. (5)

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